

In this context, the definition of a "standard" is any air interface protocol endorsed by an ANSI approved standards body such as TIA. The benefit of using only such standardized CAI's accrues directly to the end customer. With a standardized CAI, the end customer will have a choice of manufacturers and service providers from which to choose.

As the Commission is aware, several industry groups are already pursuing the development of PCS technical standards. TIA, in conjunction with T1 and Telocator, have advanced the issue greatly in the past year while displaying a sensitivity to avoid stifling future technological developments. These groups are proceeding on the belief that technical compatibility will best achieve the Commission's goal of promoting universal PCS service. Motorola actively participates in these organizations, and fully supports their endeavors.

B. Nonlicensed PCS Technical Standards

The successful deployment of nonlicensed PCS devices will require the development of sophisticated industry standards to prevent harmful interference between customer-owned or controlled devices. The WINForum is currently undertaking the task of considering a "spectrum etiquette" to accommodate a variety of new wireless offerings. Motorola anticipates that more than one etiquette will be required, given the differences between wireless voice and data applications.

Motorola, however, cautions that effective interference protection will not be confined to simple power level limitations, as implied in the Notice. Rather, it will include such provisions as Listen-Before-Talk (LBT).

In general, Motorola believes that the Commission should rely on industry standards bodies in undertaking this complicated task. However, the Commission's type acceptance rules should and must provide an enforcement mechanism to ensure that new equipment meets industry formulated non-interference standards. This underscores the need for prompt industry action and the adoption of rules which incorporate industry consensus on technical requirements.

Motorola does wish to offer comments regarding four aspects of the proposed technical rules for the unlicensed device band. First, Motorola and many in industry recognize the benefits of segmenting spectrum to allow both packet switched applications such as data and circuit switched applications such as voice to coexist within the total allocation for nonlicensed PCS. Motorola and other industry players are working diligently within the WIN Forum to define specifically the optimal channelization scheme to provide for circuit switched and packet switched applications on a fair and equitable basis. Motorola believes, that some degree of channelization, in concert with a well defined etiquette, will be needed to ensure fair access, minimize interference among nonlicensed users and optimize spectral efficiency. However, it is somewhat premature to endorse or oppose the specific channelization scheme set forth in the Notice.

Second, the Commission has proposed peak radiated output powers of 1 watt, 100 mW, and 20 mW, respectively for the 10 MHz, 1.25 MHz and 100 kHz band segments.⁵ However, studies by the WINForum show that with the proposed LBT etiquettes, wideband systems have a mutual system interference advantage over narrower band systems if the radiated power densities are equal. If the effective power density, "p", is characterized by the expression $p = K(BW)^{-1/2}$, where K is a constant equal to 1×10^{-4} , this relative interference advantage is minimized. On this basis, Motorola agrees with the WINForum that the maximum radiated power for nonlicensed systems should be as noted in the following table. Notably, using this method, 1.25 MHz systems would be allowed a maximum power of 112 mW.

| Bandwidth (MHz) | Power (mW) |
|-----------------|------------|
| 0.1 | 32 |
| 0.3 | 52 |
| 1.0 | 100 |
| 3.0 | 173 |
| 10.0 | 316 |

Third, the Commission has proposed that frequency stabilities of one part per million be maintained over a temperature range of -30° C to +50° C, with a variation of 85 to 115 percent of the rated supply voltage at a temperature of 20° C.⁶ Motorola believes this requirement is too severe for the price-sensitive services that would be located in this band. Rather than specifying a frequency stability, Motorola

⁵ See proposed 47 C.F.R. § 15.253(b).

⁶ See proposed 47 C.F.R. § 15.253(c).

recommends the Commission require that all radiated emissions stay within the channelization ultimately adopted for nonlicensed PCS devices.

Finally, Motorola concurs with the thrust of the emission masks proposed for the various nonlicensed band segments. These masks are more stringent than specifications being implemented worldwide. Nonetheless, they can be implemented in a cost effective manner that improves spectrum utilization and efficiency. Motorola recommends the limits reference an absolute power level, and that 50 dB below one Watt would be the appropriate specification. This in essence is the same level resulting from the Commission's proposed masks.

IV. PCS POWER LEVELS

The Commission has also solicited comments on the appropriate power and antenna height levels for licensed PCS services, ¶114. The matter of potential human health effects associated with radio frequency (R.F.) energy from PCS devices is addressed by the Commission in paragraphs 131-132 of this Notice. As a general response to the questions posed by the Commission, Motorola believes that PCS, like cellular radio, can be safely used, with confidence, assuming adherence to the relevant standards for the safe exposure of humans to R.F. energy.

The Commission has heretofore used the ANSI C95.1 1982 Standard as a basis for its regulation of this matter. This 1982 standard was recently updated by

IEEE and published as IEEE C95.1 (1991). It is anticipated that IEEE C95.1 (1991) will soon be adopted by ANSI.

Motorola fully supports the use of the IEEE/ANSI standard by the Commission. This standard was developed by a broad-based group of experts, representing, among others, academia, the Government, and industry. The work of this group was substantially based on important scientific criteria such as peer-reviewed papers, reproducible results, and dosimetric quantifiability.

Furthermore, the IEEE/ANSI standard is consistent with the work of other respected national and international standard bodies, such as NCRP, WHO, and IRPA/INIRC.⁷ It thus represents a sound basis upon which to prescribe regulations for the R.F. safety of PCS devices.

It is clearly appropriate for the Commission to base its regulations on a credible standard developed by others, such as that published by IEEE/ANSI. In addition, the Commission should seek and use inputs from other agencies which have relevant expertise. However, the actual promulgation of PCS R.F. safety regulations should be administered by the FCC, and should be generally patterned after the successful regulations which currently apply to cellular radio and other relevant services.

⁷ National Council on Radiation Protection and Measurements (NCRP), World Health Organization (WHO), International Radiation Protection Association (IRPA), and International Non-Ionizing Radiation Committee (INIRC).

The recently published IEEE Standard (and undoubtedly the new ANSI standard when adopted) contains provisions for a categorical exclusion of low power devices. Also, in its current rules the Commission categorically excludes all cellular related radio transmitters and other similar equipment used in the land mobile services.⁸ Motorola strongly recommends that appropriate PCS parameters be adopted which will facilitate a similar categorical exclusion. This exclusion will benefit all parties concerned. It very importantly provides a significant measure of confidence to the public that PCS radios can be safely used. Also, such an exclusion provides a simple and useful benchmark for manufacturers in designing and supplying radios to their customers. Finally, the Commission and industry benefits from clear and simplified regulatory requirements with regard to the human health aspects of PCS.

Specifically, the permitted power levels associated with PCS radios should be based upon the uncontrolled environment as defined in the current C95.1-1991 IEEE standard. The uncontrolled environment involves those people in the general public who, as a rule, are not aware of R.F. exposure from the equipment in use. For the

⁸It is recognized that the Commission has not yet determined to retain these exclusions in view of the more stringent exposure limits contained in the new IEEE/ANSI standards.

uncontrolled environment, the permitted transmitter output power level for portables operating in the 2 GHz range is $1.4 (450/f)$ watts = $1.4 (450/2000)$ or 0.31 watts.⁹

The corresponding power level for 900 MHz PCS portable radios¹⁰ is $1.4 (450/941)$ watts or 0.67 watts.¹¹ The above power limits are based upon a portable radio which employs continuous radio-frequency emission. If a modulation technique such as time-division-multiplex (TDM) is used,¹² the indicated power levels can be increased by a factor equal to the number of time slots, because the IEEE exclusions are based on average power, in the context of the modulation techniques applicable to PCS devices. ¹³

⁹See Section 4.2.2.1 of IEEE C95.1 1991. Although this exclusion criterion is shown as applying between 450 MHz and 1500 MHz, we believe it is also applicable at 2 GHz. See Appendix I for more discussion.

¹⁰In the Notice at paragraph 132, the Commission asks if certain frequencies may be more hazardous than others. The IEEE/ANSI standards accommodate this concern by prescribing limits which are frequency dependent.

¹¹A worst case frequency of 941 MHz was used here rather than a nominal 900 MHz.

¹²This, of course applies to both portable and mobile units.

¹³ Depending on the specific type of application, some portable type devices may be able to meet the IEEE/ANSI specifications with higher powers. For example, portable data devices used for PCS may normally be operated on a table top or other location which allows higher power levels.

Mobile unit power levels can generally be somewhat higher than those of portable devices, from a human health perspective, because of the associated shielding from metal surfaces and the greater distance between users and antennas afforded by the vehicle.¹⁴ For example, for a seven watt radiated power level, the required distances from an isotropic radiator to meet the IEEE/ANSI standard would be about 20 cm for the 2 GHz band and about 30 cm for the 900 MHz band. Both of these spacings should be readily achievable in a vehicular environment.

On the contrary, mobile power levels of 200 watts, as mentioned in paragraph 116 of the Commission's Notice, would require a spacing between antenna and vehicle occupants or bystanders (for 2 GHz) of 1.1 meters. This spacing is not routinely achievable even with trunk mounted antennas. Considering the recent trends towards smaller cars and increased use of plastic construction materials, Motorola recommends avoiding use of power levels such as 200 watts in mobile units.

Land Mobile base station power levels have normally not been of concern with regard to human health considerations. This, of course, is because base station antennas are normally not accessible by the public. These antennas are typically located either up on a tower or on an antenna site located on, for example, a roof. In both cases, the public cannot normally come in close proximity to the antennas.

¹⁴However, mobile powers in general need not be significantly higher than portable powers from a system design point of view.

Therefore, PCS power levels need not be limited for base stations with regard to human health except for cases where people could be in close proximity to the antenna, such as in an office or residence. In those cases, the power level should be limited to that of mobile units.

V. PCS -TO- FIXED MICROWAVE COORDINATION

The Notice generally presents a well-balanced discussion of the complex issues of PCS-to-fixed microwave interference potential and solicits comment on appropriate technical regulations which the Commission could impose in this area.¹⁵ Motorola's comments address three distinct technical issues raised: (1) the specific interference criteria to be met by the PCS operators at the microwave receiver; (2) the method of accumulating the interference potential from numerous PCS sources, and (3) the propagation model to be used between the PCS system and the microwave receiver.

¹⁵ Notice at ¶107. Motorola notes that the Notice does not address the equally important issue of OFS microwave to PCS interference potential. To the extent that no additional co-primary microwave facilities can be built, PCS licensees will likely be unaffected by the lack of such standards. However, depending on how the "no new microwave" policy is enforced, the Commission may need to define technical interference standards to protect the potentially large financial investments of PCS licensees that might be placed at risk from new microwave interference.

A. Interference Criteria to be Met at the Microwave Receiver.

The Notice notes that protection criteria between fixed microwave operations is contained in Part 94 of the Commission's Rules and further described in EIA/TIA's publication TSB10-E. The Notice expresses satisfaction with the level of protection provided under the rules and the EIA/TIA Bulletin, and proposes to provide microwave users with the same level of protection for interference from PCS operations, ¶110. At the same time, the Notice recognizes that the TSB10-E methods and procedures are based on interference between fixed microwave systems, and consequently modifications taking into account the particular technical characteristics of PCS base and mobile operations are warranted, ¶111.

Motorola notes that Part 94 of the Commission's Rules does not directly address digital OFS facilities.¹⁶ Rather, digital systems are apparently covered by Section 94.63(d)(3), which allows the use of carrier-to-interference ("C/I") ratios as "covered by generally accepted procedures," such as the EIA/TIA Bulletin. The ratios in the EIA/TIA Bulletin must, however, be reviewed by the industry to determine their continued appropriateness.

With respect to the Commission's analog OFS protection requirements, Motorola believes that many OFS systems may receive excessive protection affecting

¹⁶ See 47 C.F.R. § 94.63 (1991).

the ability of PCS to share spectrum with fixed services, as well as spectrum sharing between OFS systems. This excessive protection results from a number of factors, including:

- The fact that "very-short-haul" links (e.g., a single hop of 15 miles) use rules for links up to 250 miles total length. Section 94.63 makes no allowances for shorter paths which generally can provide high reliability with less margin.
- The existence of links with excessively high power levels, due to grandfathered status granted by Commission in 1986 when reduced power requirements as a function of link length were implemented.
- The absence of rules concerning acceptable link availability as a function of service type, which results in excessive fade margins.
- The apparent "built in" 40 dB fade margin for any analog link coordination under the current EIA/TIA Bulletin.
- Questionable interpretations of the term "practical threshold," as articulated in Section 94.63(c).

Motorola remains firmly committed to the belief that these issues relating to the current condition of the EIA/TIA bulletin can be resolved by industry through the TIA TR-14.11 committee. This on-going industry review of generally accepted engineering practices is currently envisioned by the present drafting of Section 94.63 of the Commission's Rules. The Commission must continue to provide the industry with the flexibility to continually revise this standard in appropriate industry standard setting bodies.¹⁷

¹⁷ To help expedite this process, Motorola recommends that the Commission modify Section 94.63(b)(2) to allow increased noise in proportion to total "short haul" length decreases below 250 miles. Furthermore, Motorola recommends that "practical threshold" be defined as the radio threshold sensitivity (dBm) plus the fade margin (dB), where fade margin is the excess signal in decibels required for reliable

B. Impact of Multiple PCS Sources.

The Notice proposes that each PCS licensee calculate potential interference using the signal level from each proposed co-channel and adjacent channel PCS base station and associated mobiles at the inputs of all fixed microwave receivers within a defined coordination zone, ¶111. The total power level into the microwave receiver would be calculated by straight power addition of signals from all PCS licensee's stations, id. In general, Motorola believes the proposed aggregation of the individually calculated interference potentials from the total base/mobile/portable PCS sources accurately reflects overall PCS to fixed microwave interference.

However, three important extensions to these procedures are recommended:

- Allow aggregation of base station powers at mean antenna height where: (a) all station antennas are at a similar height, and (b) the distance to the microwave receiver under consideration is substantially greater than the radius of the area of base station distribution. A factor of 3:1 is recommended to define similar height and a factor of 10:1 or greater is recommended as the distance criterion.

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operation. Motorola also recommends investigating establishment of nominal link availabilities as a function of service type, e.g., public safety, etc. Such investigation should be conducted in separate proceedings.

¹⁸ The Commission could also consider allowing the option to aggregate all base stations at the highest antenna height where more than a 3:1 factor exists, or parsing the total base compliment into groups within which there is a 3:1 maximum height variation.

- Allow licenses subsequent system modifications within the aggregation limits without requiring recoordination with microwave users. Simple notification of such changes may still be desirable, however, to keep records current.
- Although aggregation of mobile and portable power levels is an objective to be pursued, Appendix F of the Notice implies that this aggregation would be "centered" at the base station location. This may be unacceptable in situations where the cell is large and located relatively close to the microwave receiver. In these cases, further assumptions must be made regarding the two-dimensional distribution of the mobiles/portables within the cell.

These considerations, along with additional related concerns would most appropriately be addressed by an industry group charged with defining the detailed methods and procedures for coordination, such as TIA TR-14.11.

Motorola also strongly recommends that a probability term should be factored into the calculation of the expected number of PCS units to be in operation at any given time. Motorola suggests it would be relatively simple to use a straightforward method that assumes that the maximum number of mobile/portable PCS units is some percentage of the maximum base station capacity. Considering trunking efficiencies and other factors, Motorola recommends a factor of 1/2 of the maximum capacity for purposes of interference calculations.

C. PCS-To-Microwave Propagation Models

Appendix F of the Notice correctly identifies the need for "...an appropriate statistical propagation model (to) be used instead of the point-to-point models..." for

determining PCS-to-microwave protection. In this regard, Motorola is a proponent of the use of Hata's propagation prediction model, which is based on Okumura's work and results, since Motorola's tests have shown a very good correlation on many different occasions. Motorola has found that the HATA model is relatively conservative, but has limits, such as a range limit of 20 kilometers (km). The model needs to be extended, and we note that equation 9 of CCIR Report 567-4 extends the range to 100 km.

However, the basic Okumura model also reaches limits of significance; e.g., a range limitation of 100 km (60 miles). Since the proposed PCS-to-microwave coordination distances go well beyond this limit with distances of greater than 125 miles, additional modeling will be required. Although Motorola has no specific recommendations at this time, it encourages and supports a TR-14.11 initiative to develop the necessary proposals in this area. ¹⁹

Finally, Motorola notes that TR-14.11 should also define the appropriate operational environment weighting factors to be applied to portable/base PCS unit propagation losses. The Commission's recommended 10 dB and 20 dB isolation for in-building residential and business service appears to be consistent with Motorola's

¹⁹ We do, however, recommend consideration of CCIR Report 238-6, "Propagation Data and Prediction Methods Required for Terrestrial Trans-Horizon Systems" or other similar existing and generally accepted methods.

findings as well as those of various researchers who have investigated this area to date.

D. PCS/Fixed Microwave Coordination Table

The Commission has also proposed a coordination table for determining the coordination distance between PCS systems and fixed microwave stations, ¶119. The table is based on PCS base station EIRP and height above average terrain. The lowest base station power associated with the table is, however, 10 watts (EIRP) and the lowest antenna height is 90 meters. Motorola believes there is a strong likelihood that a significant number of PCS base stations will operate with lesser facilities than that in the table, in part due to reducing potential interference to microwave stations. Motorola therefore submits as Appendix B a revised table which establishes coordination distances for base stations operating with powers as low as one watt (EIRP) at a height of 5 meters. This table, which relies on the same assumptions used by the Commission, will address a significant number of real world PCS base station applications and further encourage the use of lower powers and antenna heights.

E. PCS Reliable Service Area Definition

The Commission has proposed that co-channel PCS licensees limit their signal at the edge of their service areas to a 47 dBu field strength level. While Motorola concurs with this degree of protection, it strongly disagrees with the Commission's continued reliance on Carey curve derivations to predict signal coverage. The Carey

curves were originally based on data obtained from propagation measurements at VHF and low UHF frequencies. Accordingly, their applicability at 2 GHz frequencies must be seriously questioned. Motorola urges the Commission to employ alternative prediction techniques and recommends the use of the Hata propagation model, along with more current CCIR recommendations.

VI. Establishing an Open Consortium May Be Necessary to Ensure an Effective Mechanism for Compensating and Relocating Incumbent 2 GHz Microwave Licensees

In its ongoing and interrelated Emerging Technologies proceeding,²⁰ the Commission has adopted rules and proposed further refinements to a plan designed to ensure that existing 2 GHz microwave licensees receive cost compensation and comparable new facilities in other bands before any involuntary relocation from 1850-1990 MHz spectrum is required. Thus, manufacturers and suppliers of PCS devices will necessarily have to undertake band clearing consistent with such compensation and relocation obligations. Appendix C provides a breakdown of the existing microwave systems in the 1910-1930 MHz band by state and service type.

In addition, Motorola notes that most of these links, which the Commission considers to be unpaired are actually paired with channels in the 1850-1910 or 1930-1990 band segments. Appendix C also shows the number of 1910-1930 MHz links by

²⁰ See, e.g., Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies, FCC 92-437 (October 16, 1992).

state which are paired with microwave channels in the 1970-1990 MHz band segment and therefore would not be cleared at some point as a byproduct of reaccommodating microwave systems for licensed PCS operation.²¹ In any case, such "byproduct" clearing is unlikely to occur in a sufficiently timely fashion to allow deployment of nonlicensed PCS devices nationwide.

This task is far more complicated for manufacturers of PCS devices operating on a non-exclusive basis than for 2 GHz PCS service providers receiving exclusive licensees for designated geographic areas. In the latter case, there is a single entity with a clear economic incentive to shoulder the costs and burdens of negotiating, compensating and relocating the existing microwave users. In the former case, there are a host of potential existing and future beneficiaries of the spectrum allocation with very different incentives and perceived stakes in the prompt availability of new spectrum for consumer products.

The burdens associated with relocations for PCS devices are magnified by the fact noted earlier that band clearing of the entire country is necessary for effective introduction of new offerings.²² The buyers or users of equipment control where and how the devices are used, which means that a phased in approach with market entry

²¹ This chart lists these as "unclearable."

²² This includes state and local government microwave systems which the Commission exempted from the possibility of involuntary relocation in its Emerging Technology decision.

focusing on specific cleared markets is not possible. Consumers can and will use equipment outside the initial installation area despite the best intentions and best efforts of a manufacturer. Thus, there is a constant possibility of unanticipated interference to 2 GHz operations unless and until all current microwave uses are migrated to other bands.

In order to create an effective mechanism to ensure prompt band clearing, Motorola submits that the Commission's spectrum authorization and/or equipment approval processes should require participation in the consortium as a condition to operate in the 1910-1930 MHz band. Through an industry consortium operating under ground rules that ensure open entry for all manufacturers, the Commission can avoid the regulatory delays associated with market-by-market, exclusive licensing procedures. At the same time, the Commission can provide the incentives for full industry participation in establishing a pool and process for promptly relocating 2 GHz licensees to other spectrum homes.

In particular, Motorola suggests that the Commission consider the following possible framework for addressing this thorny problem:

- The PCS device industry would establish a non-profit entity either associated with an existing trade association or through a new organization.
- The non-profit entity would be open to membership by any company agreeing to participate on an equitable pro rata basis in funding a "compensation pool" for the relocation of 2 GHz microwave licensees operating in the spectrum allocated for PCS devices.

- The FCC would either issue a blanket license for use of the PCS device spectrum to the industry entity, establish a private frequency coordinator and/or require that suppliers of PCS devices participate in the compensation pool in order to receive FCC equipment approval.
- In order to apply for type acceptance for equipment to operate in the PCS device bands, the manufacturer would have to certify its membership in the licensee.
- No end user or other licensing would occur.
- Commission rules would specify the general terms for the entity's procedures to ensure fair participation by members.
- The criteria for participation in the entity holding the blanket license would be compliance with FCC rules and an agreement to participate in funding the "compensation pool".

Motorola believes that the mechanism outlined above would provide a necessary basis for ensuring the ability of the PCS device industry to rapidly and efficiently clear allocated spectrum for consumer products and offerings. Absent such a mechanism, controversies and delays are sure to ensue. An open industry consortium would provide a means to achieve the early dividend for new non-licensed PCS capabilities envisioned by the Commission.

VII. THE COMMISSION MUST MODIFY THE LICENSING PROCESS TO CURB SPECULATION

The Notice lists three possible options for selecting PCS licensees: comparative hearings, lotteries, and competitive bidding, ¶82. As a practical matter, auctions are not currently available in the absence of Congressional enabling

legislation, *id.* The Notice tentatively rules out comparative hearings for PCS licensing on the basis that they are slower and more costly to both applicants and the Commission, *id.* That leaves lotteries as the only option for the selection of PCS licensees. Unfortunately, Motorola believes that expedited comparative hearings may continue to be the best mechanism for license assignments. Assigning licenses by chance may not provide the same level of protection to the public interest as comparative hearings

A. The Commission Must Take Steps To Minimize the Filing of PCS Applications by Unqualified Speculators

If lotteries are ultimately deemed to be desirable by the Commission, steps should be taken to prevent speculative abuses. Motorola recommends the following steps:

1. Filing fees imposed on PCS applicants should be high enough to prevent speculation;
2. Applicants must demonstrate market-specific financial qualifications;
3. Minimum construction deadlines and coverage requirements should be imposed;
4. Mass produced engineering proposals should be rejected;
5. Applicants should demonstrate reasonable assurance of sites availability;
6. Interests in multiple applications for the same area should be prohibited.

Motorola believes taking these steps will curb speculation to ensure the maximum participation by legitimate potential PCS operators.

VIII. CONCLUSION

Motorola strongly supports the Commission's proposed actions allocating spectrum and establishing policies and rules to enable the introduction of PCS. These new advanced communications services will have a significant impact on consumers, businesses, and domestic competitiveness in global communications markets, and the framework proposed in the Notice for realizing these benefits is generally well crafted. Motorola believes, however, that the Commission's four values for PCS -- universality, speed of deployment, competitive delivery, and diversity of service -- would be furthered by adopting the revised technology-neutral channel plan Motorola has outlined above, and by incorporating Motorola's suggested refinements of technical and operating rules for PCS services. Motorola also urges the Commission to act promptly on the proposals in the Notice, and bring the dividends of advanced communications services to the public and private sectors with minimal regulatory delay.

APPENDIX A

MODIFICATIONS TO PROPOSED 900 MHZ RULES

Technical Rules for 900 MHz Narrowband PCS

In addition to adopting the bandplan set forth in these comments, Motorola recommends several changes be made to the specific rules proposed in the Commission's Notice for 900 MHz Narrowband PCS. In essence, these changes would:

1. Abandon the use of emission designators or set new designators or all possible modulation types.
2. Allow full utilization of authorized bandwidths as may be required by modern modulation methods while retaining current emission limits outside the authorized bandwidth.
3. Employ comparable emission limits outside the authorized bandwidth, regardless of channel width and specify the appropriate authorized bandwidths for various channel widths.
4. Allow wider bandwidth systems to utilize proportionately higher powers.

The following suggests specific rules changes by sections referenced to those proposed in the Notice:

Reference: § 22.104, §90.207 Emission types

Change needed: Do not restrict the type of modulation to one of the predefined designators as long as the emission limits (§ 22.106, § 90.209) are complied with.

Reason: New spectrally efficient technologies may not correspond to any of the existing emission designators. The need for a rule change to introduce an improved technology will inhibit the introduction of new technologies without providing any apparent benefit.

Reference: § 22.105 Bandwidth, § 22.507, § 90.209 Bandwidth and emission limitations, §2.989 Measurements required: occupied bandwidth

Change needed: Authorized bandwidths should be not only 10 kHz for 12.5 kHz channelization and 20 kHz for 25 kHz channelization as currently proposed, but also 45 kHz for 50 kHz channelization and 145 kHz for 150

kHz channelization.

Reason: New spectrally efficient technologies require full utilization of the available bandwidth. Otherwise the best utilization of the available spectrum is not possible. The new bandwidths recommended here all have the same width guard band between channels and will provide the same level of interference protection to old technology equipment designed for 25 kHz channelization.

Reference: § 22.106, § 90.209 Emission limit

Change needed: All references to "unmodulated transmitter carrier power" and "unmodulated carrier power" should be changed to "transmitter power".¹

Reason: Unmodulated carrier power is meaningful only for FM transmitters. New technology may use a suppressed carrier, or no carrier at all. In addition the instantaneous transmitter power varies for non-FM technologies. Carrier power and transmitter power are the same for FM transmitters, so this change yields the same result as current rules for an FM transmitter and extends the intent and interference protection attribute of the original language to the new technologies.

Reference: § 22.106, § 90.209 Emission limit.

Changes needed:

For transmitters not equipped with an audio low pass filter required by the provisions of [paragraphs (f) and (g) of § 22.508] [§ 90.211(d)(1)], and for those employing digital modulation techniques, the power of any emission shall be attenuated below the transmitter power (P) in accordance with the following schedule:

¹ Measurement methods for emission limits should remain consistent as in the proposed rule change below. The note following § 22.106 has been changed from "Note: The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the unmodulated transmitter carrier power (P)." to "Note: The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the transmitter power (P)."

(1) For transmitters that operate in the frequency bands 901-902, 930-931, 940-941 MHz, and are authorized for a bandwidth in kHz (B) of 20 or greater:

(i) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of up to and including 40 kHz: at least $116 \log_{10} [(f_d+10)/6.1]$ decibels or 50 plus $10 \log_{10}(P)$ or 70 decibels, whichever is the lesser attenuation;

(ii) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 40 kHz: at least 43 plus $10 \log_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation.

Note: The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the transmitter power (P).

(2) For transmitters that operate in the frequency bands 901-902, 930-931, 940-941 MHz, and are authorized for a bandwidth in kHz (B) of 10:

(i) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of up to and including 20 kHz: at least $116 \log_{10} [(f_d+5)/3.05]$ decibels or 50 plus $10 \log_{10}(P)$ or 70 decibels, whichever is the lesser attenuation;

(ii) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 20 kHz: at least 43 plus $10 \log_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation.

Note: The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the transmitter power (P).

Reason: (1)(i) and (ii) yield the same out of band attenuation as the current standards for 20 kHz bandwidth transmissions. The formulas have been rewritten to reference the edge of the authorized bandwidth instead of the center. Thus the shape of the attenuation curve is the same for any value of authorized bandwidth. The protection provided to adjacent channel services using older technology designed for 25 kHz channelization is thus independent of the transmitting channel bandwidth. At the same time, the central portions of wider channels can be more fully utilized for better spectral efficiency.